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CONTENTS

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SOME ENERGY RELATIONS OF PLANTS[1]

THE science of botany is about one hundred and fifty years old. Great changes have occurred during this time in the point of view from which botanists look at the plant.

The first scientific interest in plants was in merely naming them. In the latter part of the eighteenth century Linnæus extended the use of generic names which were already in use, added species names for greater convenience in handling his herbarium specimens, and thus established the binomial system, now in universal use in naming plants. Thus was laid the foundation of taxonomy as the earliest phase of the science of botany.

Linnæus clearly saw that the next step in the advance of botanical knowledge was to be classification. He himself made some crude attempts at arranging plants in classes. His system he well knew to be artificial. He clearly foresaw that more complete knowledge of the structure of plants, particularly of their buds, flowers and fruit, would ultimately lead to the classification of flowering plants in a natural system. His successors were busy with the attempt to learn enough of this structure of reproductive parts to enable them to put plants into a systematic classification according to their natural relationships.

This gave rise to morphology as the second great phase of the advance of botanical

[1] Address as retiring president of the University of Washington Chapter, Sigma Xi, Seattle, June 4, 1918.

science. It has gone a long way toward its goal of securing and interpreting data bearing on the order of the evolution of the various groups of plants and of thus putting classification on a natural basis. Morphology stands to-day with somewhat changed ideals as one of the big phases of modern botany. Contributing to evolution and working along with it, it offers a large field for investigation. A little later men began to interest themselves especially in the functions of plants—how they make their food, and from what raw materials it comes. This gave rise to plant physiology, the science which lies at the basis of the problems of plant production.

Following this, the destruction of growing crops by parasites led to a scientific study of the organisms that cause plant diseases. This interest in the mutual relation of host and parasites is the foundation of plant pathology, a subject having large possibilities in increasing food production as well as attractive from the standpoint of pure science.

In 1895 the publication of Warming's book focused interest on a new point of view in botany—that of plant societies living together as communities, limited as well as favored by a common environment, but not grouped at all according to their natural relationships in a morphological sense. This has given rise to ecology—a somewhat unorganized, but hopeful phase of modern botany.

We now have, then, four main lines of interest in modern botany—morphology and evolution, pathology, physiology and ecology. In the broadening of our knowledge of plants and of our interests in them, we have gotten far from the point of view of those who looked upon plants as merely things to be named—of those whose interest in plants was merely in the ear marks that might be useful for identification. In the shifting of interest from this mere naming of plants to their natural classification as based upon their structure and reproduction, and the broadening of this into interest in their functions, their health, their diseases, and even their mutual relations in plant societies, interest in the plant as a living thing has naturally developed.

In all of the modern phases of botany the tendency now is to look upon the plant as a living organism with work of its own to perform its own problems of existence to solve. In the very early stages of this interest it seemed to many persons that the mere statement that the plant was a living thing was a sufficient explanation of the phenomena shown in its activities. Perhaps this may still seem so to some.

The search for a "vital principle"[2] at first based on observation and speculation, but later professing to find some basis of support in the facts of modern experimental biology has proved unsatisfactory as not contributing to progress. Whether it is the "entelechy" of Driesch or the "x-entity" of Ganong it offers only slight help in getting anywhere. Neither the vitalist nor the neovitalist offers us a program for work.

During the years immediately preceding 1900 the tendency to postulate some sort of material particle as the ultimate basis of life was dominant. These particles or corpuscles were supposed to consist of more than one molecule and it was from them that the organism was built up in one way or another. They were also supposed to be the bearers of heredity.

In botany corpuscular theories resulted largely in research, the basic idea of which was that the chromosomes produced in the nucleus at the time of cell division are the bearers of heredity. Since these bodies are

[2] *Cf.* Child, Senescence and Rejuvenescence," Chap. 1.

plainly visible in a dividing cell under the microscope, attention was naturally focused upon them. However, even if any one succeeded in connecting up the transmission of some particular character to the offspring with some peculiar form of one of the chromosomes we still had the question of why that particular form was connected with that particular character. Thus little was accomplished so far as the fundamental problem was concerned. Although much knowledge was gained by investigations of this sort, they still furnished no means of direct attack upon the fundamental problem.

Investigations of the sort just mentioned illustrate the first fundamental defect of all corpuscular theories, considered as a means of advancing our knowledge of biology, viz., the corpuscles are hypothetical and thus merely serve to put biological problems beyond the reach of scientific investigation.

A second defect of corpuscular theories is that they provide no adequate mechanism for the correlation of the various organs making up a complex organism. Means of securing dominance of one part and subordination of another are lacking.

With the advance of knowledge of physics and chemistry and the growing interest in experimental plant physiology, the point of view in regard to plant functions shifted and we were chiefly concerned for a time with what may be called the chemical point of view in considering the phenomena involved in the activities of living organisms. It is of course, evident that chemical reactions play a large part in the life processes. It is also well known that life is closely associated with the substance which we call proteins. This gave rise to the idea that certain complex protein molecules are the "producers of life."

Though the molecule itself according to this conception is not alive, its constitution is the basis of life and life results from the chemical transformations which its lability makes possible. The living substance, then, says the explanation of life, is a substance in which some of the labile molecules are continually undergoing transformation. Life itself would then consist in chemical change, not merely in chemical constitution. Death must then be regarded as a change from lability to stability. The dead proteins, which the chemist might analyze could not of course, show the properties of the living substance, and the fundamental problems of life were thus again placed outside the realm of experimental science.

About 1900 questions began to be heard as to the existence of a "living substance" of more or less definite chemical structure. We are indebted largely to Höber's book published in 1911 for crystallizing our ideas as to the hopelessness of the purely chemical point of view and pointing the way to the physico-chemical, for starting us away from the idea that protoplasm is merely a complex chemical substance, toward the conception of protoplasm as composed of many chemical substances existing as a complex physical system. This assuming a colloid substratum for the organism, is the physico-chemical theory of life which represents the prevailing point of view in the biology of to-day.

This leads us to look upon the plant as a living physical system, receiving energy from its environment and doing work that is more or less useful to itself and to mankind. It points the way to a definite program for work and is then a source of gratification to the modern experimental botanist.

"The situation at present," says Dr. Briggs,[3] "may perhaps be fairly summar-

[3] *Jour. Wash. Acad. Sci.*, 7: 89, 1917.

ized as follows: The mechanism of plant processes not at present explainable on a physico-chemical basis would be termed by the vitalistic school as 'vital,' by the physico-chemical school 'unknown.'" This well expresses the current thought of experimental biologists.

When we have once recognized our ignorrance and have found a means of learning, the situation looks more hopeful. Having arrived at this physico-chemical conception of the organization and activities of the living plant, the energy point of view furnishes the best means now available of making the experimental attack on the nature of the processes involved in plant metabolism. Change in the physical system must always be conditioned by the energy available. Since we look upon the living plant as a physical system we must be concerned with its energy transformations. We have until very recently considered the activities of the plant largely from the view point of the materials received by it from the outer world and the products formed from these materials. Now we are turning our attention toward the question of what forms of energy the plant may be able to use in these various transformations, or rather, we are broadening our vision to include both the materials and the energy.

In our consideration of the energy relations of plants we are largely concerned with four questions: (1) From what sources does the plant receive its energy? (2) What work does it accomplish by means of the energy received? (3) How effectively does it use this energy? (4) In what classes of plant problems does the energy point of view suggest a hopeful means of attack in research.

Under certain conditions the plant may absorb heat from the surrounding air. It also commonly takes in from the soil solution and perhaps even from the air certain energy containing compounds. Still the plant receives much of its energy directly from the sun in the form of light rays. What we know of its reception and use by the plant is largely confined to that portion lying within the visible spectrum, though some scientific excursions have been made into the realms of the ultra-violet and the infra-red rays.

The leaf is the most useful portion of the plant for receiving and utilizing this radiant energy of the sun. Being by nature a surface-exposing organ, the leaf brings its green cells into such a situation that they advantageously receive light energy from the sun's rays.

It is in the green cells of the leaf that those transformations of energy take place, which are most significant to the plant in its own problems of existence as well as to man in his.

The radiant energy falling upon the leaf of the plant may be disposed of in several ways. Some of it is reflected from the leaf surface and is then lost so far as its immediate effect upon the plant is concerned. This is a very small amount, but still it can not be entirely neglected.

Some of the sun's energy passes entirely through the leaf and is then also lost. Direct measurements of both the intensity and the wave-length of the light thus passing through the leaf have been made. Some of the energy retained by the leaf is used in evaporating water from the surface of the leaf. This is a much larger amount than both of the preceding combined. The amount of water thus evaporated from the aerial portion of a plant is large relative to the weight of the plant itself. Grass plants often give off in the form of vapor in every twenty-four hours of dry hot summer weather, a quantity of water equal to their own weight. The grass of an ordinary city lot 50×125 feet would give off

under these conditions about 125 gallons of water in every twenty-four hours. If this is raised an average of 1 foot, it means the expenditure of 1,100 foot pounds of energy per day through the medium of the grass on the city lot.

A birch tree standing in the open has been found to give off over 800 pounds of water per day. A man equipped with two ordinary water pails would have to make thirty-two trips in order to carry this amount of water. If he had steps up to the top of the tree and could make a round trip very ten minutes he would work over five hours per day to carry this amount of water.

This evaporation is a large factor in raising water to the tops of plants. Recent investigation indicates that this molecular diffusion which we call transpiration exerts suction throughout the whole vascular system of the plant—leaves, branches, stem and roots. The contained water seems to be under tension even to the tips of the roots.

Transpiration operates through osmosis in leaf cells and through the tensile strength of the water column in the conductive tubes of the plant to accomplish this. While the actual vaporization of this water is dependent solely upon the evaporation power of the air (*i. e.*, temperature and relative humidity of the air actually in contact with the leaf cells) it is very probable that other forces arising from the presence of energy containing compounds in the plant are largely responsible for placing this water on the surface of the cells where the evaporating power of the air can act.

I have now mentioned two ways in which the plant allows radiant energy to escape without making use of it, and one way in which it uses it. The fourth possible fate for this energy is in food synthesis by the plant. A very large amount of the radiant energy received by the leaf is used in making compounds of high energy content from compounds of low energy content. The basic process in this group of synthesis is the manufacture of sugar and starch from carbon dioxide and water. This process depends upon the catalytic action of chlorophyll, the green coloring matter of plants.

This is a reduction process resulting in the storing of energy in such a form that it may be released by oxidations, such as occur in respiration, for the use of the plant. If not thus freed for the direct use of the plant this energy may remain stored in the form of coal or of hydrocarbon oils, and even ages after its capture by the plant may furnish heat for our homes or power to drive our railway trains or autos. More immediately it furnishes us through our food, all of which comes directly or indirectly from plants, the energy to perform work with our hands and our brains. The activities of the world are based on photosynthesis—the reduction of carbon dioxide by the plant resulting in the formation of carbohydrates.

This series of syntheses started in the formation of carbohydrates by the plant is important in the more direct production of mechanical energy, as well as in the matters just discussed. It is perhaps looking far into the future to consider a time when the world's supply of coal and of hydrocarbon oils may be exhausted, but such a time may come. If we keep up our present rate of stripping the earth of its clothing of forest trees, the supply of wood will not last forever and a constantly increasing portion of it will be necessary for structural purposes. The situation tends to turn our attention toward those sources of energy, which are not destroyed in the using and those that are capable of renewal within a brief time by growing plants.

The utilization of water falls and the employment of solar engines come under the first head. Here in the West we are utilizing, in electrical form, a considerable amount of energy from water falls and rapids, and have only just begun on the development of the possible power sites of the region. While many other localities can develop considerable amounts of energy in this way, not all portions of the earth are so well favored. Solar engines are reported to be in successful operation in a few places where the total annual amount of sunshine is unusual. Even with the full use of hydroelectric power and of solar engines, the situation, while not appearing serious for the immediate future, is such as to cause us to look with interest at the possibility of alcohol and other plant products as a source of energy.

In addition to the uses above mentioned for this energy, it may also function in other processes going on within the plant and necessary for its life and growth, and thus for its continuing to function in making possible the existence of human life on the earth. The intake of water by the plant from the soil solution seems to be mainly through the process of osmosis, although there seems to be much reason now for believing that we have been placing entirely too low an estimate on the part played by imbibition. In either case, the energy for the intake of the enormous quantities of water evaporated from the plant as well as the considerable amount used in the synthesis of food substance resides in the substances elaborated by the plant from the raw materials taken in from air and from soil solution.

Osmosis and imbibition are processes whose energy is largely traceable ultimately to the photosynthetic activity of the plant itself or of other plants either recently or in the remote past. Among the important results of this intake of water is the maintenance of form in the softer parts of plants, due to the fact that their cells are so full of water as to be turgid. Everyone is familiar with the loss of form by the leaves and young stems in wilting, *i. e.*, a loss of the turgidity of its cells.

Considerable amounts of work are done by plants in their mechanical effect on obstacles that come in the way of their growth. Striking evidence of this was seen on the campus in the spring of 1910 where the large ferns buried under the asphalt put down on the campus roadway during the preparation for the exposition of 1909, burst through these roadways at numerous points and continued healthy growth until trodden down by the increasing number of students and faculty of the university. By the further expenditure of energy the plant increases the extent of its own tissue by cell division and by the thickness of the walls of these cells, resulting in rigid tissue which are the main factor in the mechanical strength of older woody portions of plants. This energy comes to the aid of man in supplying wood and coal for fuel and for the various uses which wood finds in the structures incident to modern civilization.

There are other minor uses for the radiant energy received by the plant from the sun. Under certain conditions a limited amount of it may go to keep up the temperature of the leaf to that of the surrounding air. A certain amount of the sun's energy finds its use in the locomotion of the adult form of a few lower plants and of minute reproductive bodies in many higher plants. A small amount through oxidation results in the production of luminosity in a limited number of plants.

The plant uses this energy inefficiently. The potential energy stored up in the plant, as measured by determining the heat of combustion, is only 1 per cent. to 5 per

cent. of the total energy received from the sun. Thus 95 per cent. to 99 per cent. of the energy received is dissipated by the plant.

The energy point of view has helped greatly in clarifying our methods of thinking on biological problems. As a result we are now experimenting along lines that give great hope for future success.

Luminosity in plants was for a long time an intangible will-o-the-wisp—a foundation for belief in ghosts. It was not until it was studied as an oxidation that the facts were established and the mystery cleaned up.

Our study of the intake of water by plants from the soil solution has in the past consisted too much in the substitution of the word "osmosis," for any clear notion of the nature of the processes that really take place. A good deal of thought unfortunately not so far resulting in much experimentation is now being directed toward the nature of the energy involved in the two processes for which we use the names "osmosis" and "imbibition."

Considerable more thought and experimentation have gone into attempts to understand the kinds and magnitude of the energy involved in the raising of water to the tops of plants. The chief progress in this field during recent years has been the result of thinking in terms of energy.

Among the many important economic contributions made by botanists during the last few years, a piece of work by Briggs and Shantz[4] on crop plants for arid regions well illustrates the usefulness of thought along energy lines. Plants that flourish without irrigation in these arid regions must, of course, be able to get along with very little water. They found that the efficiency with which these plants use radiant energy is inversely proportional to their water requirement. Hence, instead of introducing from more humid regions the plants of high water requirement and trying to supply to their roots all of the water that they can use, a more profitable line of endeavor seems to be that of the reduction of the water requirement of varieties of crop plants that are to be grown in these regions. There are two lines of endeavor that seem hopeful in this—the selection of varieties having low water requirements and the lowering of the evaporation rate by artificial means, thus lowering the water requirement of the plant.

The field of photosynthesis is an extremely important one for the use of the energy point of view. All of the probable steps in the synthesis of carbohydrate from inorganic nature have now been repeated in the laboratory. In the main, however, this has been accomplished by employing forms of energy probably not available in the plant. The search for the energy that may be available for this synthesis should engage much of the attention that is now going merely to a consideration of the materials involved.

Some confusion on the energy involved in the process has resulted in the past from the fact that a few of the earlier workers had differences in intensity when they thought they had only differences in wave length. However, clearer thinking and better apparatus are already pointing to definite progress in this field. The photoelectric cell has already been employed in plant physiology as a means of measuring the light intensity under which the plant is carrying on its life processes and important data will undoubtedly be obtained through its use by future investigators.

The energy point of view has already helped greatly in our understanding of carbohydrate synthesis in plants and promises still more in the future for progress in

[4] *J. Agr. Res.*, 3: 1–63, 1914.

our understanding of this process so fundamental to our well being and happiness and even to existence itself. The energy point of view is the keynote of modern investigations in plant physiology.

This method of thinking is proving beneficial not only in those biological problems upon which direct experimentation is possible but also in giving clearer notions of some processes that have taken place in the past and appear to be at the present time outside the realm of possible experimentation.

Thought as to the possible steps involved in the early stages of organic evolution furnishes a good example of this. We are now getting away from a consideration of merely the form of the possible organisms which represented the first stages in the evolution of higher plants and animals and are now considering what forms of energy they could have utilized. Since we can hardly suppose that the first step from the non living to the living involved the presence of chlorophyll we think about them in terms of the possible forms of energy that they could have found available. Progress is being made by this kind of thinking. The suggestion that it at present offers is that sulphur and iron bacteria being able to oxidize inorganic compounds and being thus free from the necessity of the presence of chlorophyll on the earth, probably represent very early stages in organic evolution.

The usefulness of the energy point of view is thus apparent. It is not profitable to think longer in terms of vital force, of corpuscular responsibility for inheritance, nor alone in terms of the chemical compounds involved. We think rather of the energy transformations as related to both physical and chemical conditions. Does it not seem evident that the line of future progress in many fields of botanical investigation will be largely along the paths seen from the view point of energy transformations in the plant?

George B. Rigg

Seattle, Wash.

EDUCATIONAL EVENTS

THE DEATH OF THORILD WULFF

A letter from Peter Freuchen, the Danish factor at Knud Rasmussen's Station at North Star Bay, Northwest Greenland, written in late February, gives a direct and definite account of the death of Dr. Thorild Wulff, Swedish botanist and ethnologist, who accompanied Knud Rasmussen on his recent trip to Peary Land and return across the Greenland ice-cap. Translated from the Danish, part of the letter is as follows:

The party, composed of Knud Rasmussen, leader; Lauge Koch, geologist and cartographer, and Dr. Thorild Wulff, botanist and ethnologist, left North Star Bay, as you probably know, early in April, 1917. They were accompanied by four Eskimo—Hendrik Olse, Inukitsok ("Harrigan"), Ajago ("Pingasut") and Boatsman.

They traveled without mishap as far as St. George Fjord, where difficulties began—no game at all, with the exception of a few hares and a seal or two; scarcely a trace of muskoxen. Hence they could go no farther than De Long's Fjord. Here they started homeward, exhausted, and much depressed by the loss of Hendrik, who was devoured by wolves while out hunting. Weak from lack of food, he had apparently lain down to sleep, and before he could defend himself, the wolves had overcome him.

The others talk of the return journey over the ice-cap as a bad dream. After incredible difficulties, they finally attained the west coast at Cape Agassiz near the Humboldt Glacier, just a short time after they had eaten their last dog.

Knud Rasmussen and Ajago at once started on a forced march to Etah to get aid. The others were to rest a little, and then follow slowly after, trying to kill enough game to sustain them. After a few days slow travel without any food, Dr. Wulff could go no farther, and laid himself down to die. He wrote messages to his children and his parents, and dictated to Koch a brief survey of the vegetation about Peabody Bay, for he had continued his observations to the last. He was so weak and ex-

hausted that he knew he could not last much longer.

Forced to abandon him if they were to survive, Koch, Inukitsok and Boatsman went slowly, on farther. Just as they were about to give up entirely, they killed two caribou that kept them alive until relief came from Etah.

Later in the fall, I went up to bury Dr. Wulff, but I could not find his body because of the darkness.

Dr. Wulff has done a very fine piece of work, both botanical and zoological, along the whole coast that he traversed. Koch has also done good work. He succeeded in mapping accurately the whole coast along which the party traveled, including several hitherto unknown fjords. He found the former maps inaccurate in many places. He has moreover brought back a few Silurian and Cambrian fossils from far north.

Koch is not yet (February 23, 1918) quite well, but now that we have brought him to Upernivik and the care of Dr. Bryder and the other good people here, he is fast regaining his strength and health.

This excerpt narrates without embellishment one more of the incidents that make the annals of the North so full of tragedy. The name of Dr. Thorild Wulff is one more added to the long list of heroes lost in Arctic service. Sweden may well be proud to claim him.

W. ELMER EKBLAW
UNIVERSITY OF ILLINOIS

RETIREMENT OF DEAN EDWARD H. BRADFORD OF THE HARVARD MEDICAL SCHOOL

AFTER thirty-eight years of service on the faculty of the Harvard Medical School, Dr. Edward H. Bradford, has tendered his resignation to take effect on September 1. At the Commencement exercises President Lowell announced a gift of $25,000 from an anonymous source to found the Edward Hickling Bradford fellowship, which is to be used for research or instruction separately or in connection with any other foundation at the Harvard Medical School in such manner as the Harvard Corporation may from time to time prescribe. Dr. Frederick C. Shattuck, Jackson professor of clinical medicine emeritus, pays the following tribute to Dean Bradford in the current issue of the Harvard Alumni Bulletin:

It were unpardonable, even in these stressful days, to allow the resignation of Dr. Bradford as dean of the faculty of medicine to pass unnoticed.

Six years ago, just at the time he had freed himself from hospital work, and had also resigned the professorship of orthopedic surgery of which he was the first incumbent, putting aside the prospect of well-earned leisure and realizing that his private work was likely to suffer, he listened to the call and assumed the deanship. Almost year by year the work of the dean's office has increased with the growth of the medical school, with the expansion and complexity of its activities. It had been his intention not to hold office more than five years; but the exigencies growing out of the war, into which we had just entered, seemed to make it desirable for him to add another year.

Among the developments which have occurred during his tenure of office may be mentioned: the graduate school of medicine so ably headed by Dr. Arnold; the school of tropical medicine under Dr. Strong; the school for health officers under the joint charge of the department of preventive medicine and the Massachusetts Institute of Technology; the further extension of preventive medicine into the fertile field of industrial health and occupational disease, the plans for the opening of which in the coming September are now being laid out; entrance examinations have been revised so as to permit greater elasticity without letting down the bars. A new system of examinations leading to the M.D. degree has been applied.

The Harvard Infantile Paralysis Commission was appointed in September, 1916, following the epidemic of that summer, and is still active. As a member of the committee on education of the American Medical Association Dr. Bradford kept in close touch with nation-wide thougnt on this subject, and made Harvard influence felt.

It was due to Dr. Bradford's firmness that fourth-year teaching was carried on through the summer of 1917 in Harvard and Columbia, enabling students to graduate in March.

In these and many other matters, Dr. Bradford has taken initiative, or given sympathetic encouragement or guidance. There has been a notable increase in the number of students, both under graduate and graduate in the six years he has been dean. "Well done, good and faithful servant."

THE CHEMICAL WARFARE SERVICE

BY order of the Secretary of War General Peyton C. March has issued under date of June 28, the following general orders:

I. 1. Under authority conferred by sections 1, 2, 8 and 9 of the act of Congress "Authorizing the President to increase temporarily the military establishment of the United States," approved May 18, 1917, and the act "Authorizing the President to coordinate or consolidate executive bureaus, agencies and offices, and for other purposes, in the interest of economy and the more efficient concentration of the government," approved May 28, 1918, in pursuance of which act the President has issued an executive order dated June 25, 1918, placing the experiment station at American University under control of the War Department, the President directs that the gas service of the army be organized into a Chemical Warfare Service, National Army, to include:

(*a*) The Chemical Service Section, National Army.

(*b*) All officers and enlisted men of the Ordnance Department and Sanitary Corps of the Medical Department as hereinafter more specifically specified (regular officers affected being detailed and not transferred).

2. The officers for this service will be obtained as provided by the third paragraph of section 1 and by section 9 of the act of May 18, 1917, the enlisted strength being raised and maintained by voluntary enlistment or draft.

3. The rank, pay and allowances of the enlisted men of the Chemical Warfare Service, National Army, shall be the same as now authorized for the corresponding grades in the Corps of Engineers.

4. The head of the Chemical Warfare Service, National Army, shall be known as the Director of the Chemical Warfare Service, and, under the direction of the Secretary of War, as such, he shall be, and hereby is, charged with the duty of operating and maintaining or supervising the operation and maintenance of all plants engaged in the investigation, manufacture, or production of toxic gases, gas-defense appliances, the filling of gas shells, and proving grounds utilized in connection therewith and the necessary research connected with gas warfare, and he shall exercise full, complete and exclusive jurisdiction and control over the manufacture and production of toxic gases, gas defense appliances, including gas-shell filling plants and proving grounds utilized in connection therewith, and all investigation and research work in connection with gas warfare, and to that end he shall forthwith assume control and jurisdiction over all pending government projects having to do or connected with such manufacture, production and operation of plants and proving grounds for the army and heretofore conducted by the Medical Department and Ordnance Department under the jurisdiction of the Surgeon General and the Chief of Ordnance, respectively, and all material on hand for such investigation or research, manufacture or production, operation of plants and proving grounds, and all lands, buildings, factories, warehouses, machinery, tools and appliances, and all other property, real, personal or mixed, heretofore used in, or in connection with, the operation and maintenance of such plants and proving grounds for the purpose of investigation or research, manufacture or production, already procured and now held for such use by, or under the jurisdiction and control of the Medical Department or the Ordnance Department, all books, records, files, and office equipment used by the Medical Department or the Ordnance Department in connection with such investigation or research, manufacture or production, or operation of plants and proving grounds, all rights under contract made by the Medical Department or Ordnance Department in, or in connection with, the operation of such plants and institutions as specified herein, all rights under contract made by the Medical Department or Ordnance Department in, or in connection with such work, and the entire personnel (commissioned, enlisted and civilian) of the Ordnance Department and Sanitary Corps of the Medical Department as at present assigned to or engaged upon work in, or in connection with, such investigation or research, manufacture or production, or operation of plants and proving grounds, are hereby transferred from the jurisdiction of the Ordnance Department and the Medical Department and placed under the jurisdiction of the Director of the Chemical Warfare Service, it being the intention hereof to transfer from the jurisdiction of the Medical Department and the Ordnance Department to the jurisdiction of the Chemical Warfare Service, every function, power and duty connected with the investigation, manufacture, or production of toxic gases, gas-defense appliances, including the necessary research connected with gas warfare, gas-shell filling plants, and proving grounds utilized in connection therewith, all property of every sort or nature used or procured for use in, or in connection with, said operation of such plants and proving grounds and the entire personnel of the Ordnance Department and Sanitary Corps of the Medical Department as at present assigned to, or engaged upon work in, or in connection with, the operation and maintenance of such plants engaged in the investigation, manufacture or production of toxic gases, gas-de-

fense appliances, including gas-filling plants and proving grounds utilized in connection therewith.

5. All unexpended funds of appropriations heretofore made for the Medical Department or Ordnance Department and already allotted for use in connection with the operation and maintenance of plants now engaged in, or under construction for the purpose of engaging in, the investigation, manufacture or production of toxic gases or gas defense appliances, including gas-shell filling plants, are hereby transferred to, and placed under the jurisdiction of the director of the Chemical Warfare Service for the purpose of meeting the obligations and expenditures authorized; and, in so far as such funds have not been already specifically allotted by the Medical Department and the Ordnance Department for the purposes specified herein, they shall now be allotted by the Secretary of War, in such proportions as shall to him seem best intended to meet the requirements of the situation and the intentions of Congress when making said appropriations, and the funds so allotted by the Secretary of War to meet the activities of the Chemical Warfare Service, as heretofore defined herein, are hereby transferred to, and placed under the jurisdiction of, the director of the Chemical Warfare Service for the purpose of meeting the authorized obligations and expenditures of the Chemical Warfare Service.

6. This order shall be and remain in full force and effect during the continuation of the present war and for six months after the determination thereof by proclamation of the treaty of peace, or until theretofore amended, modified or rescinded.

II. By direction of the President, Major General William L. Sibert, United States Army, is relieved from duty as director of the Gas Service, and is detailed as director of the Chemical Warfare Service, National Army.

TRAINING OF COLLEGE STUDENTS FOR MEDICAL CORPS OFFICERS[1]

THE Medical Department of the Army, through the National Research Council, will shortly issue an appeal to American colleges and universities urging them to alter their curriculum so that third and fourth year students may receive special training which will enable them to qualify as officers and for other work in the Medical Department.

The appeal will be sent to all the principal colleges and universities in the country, but as it is realized that important institutions may not for various reasons receive the appeal, the request is made that all directing heads of such institutions write to either Dr. Richard M. Pearce, of the National Research Council, Washington, or to the Division of Laboratories, Office of the Surgeon-General, Washington, for details of the proposed plan.

These colleges will render valuable assistance to the government by offering these special course to their students who will enter the Army when they become of age or in the event that they volunteer before that time. The students desired are those who are taking the various scientific courses. The course proposed by the Medical Department should appeal to men who are specializing in biology, zoology, plant pathology, and in industrial and agricultural bacteriology.

In a number of institutions the necessary courses can be arranged by a simple modification of the already existing course in bacteriology with added emphasis on special subjects of value to the Army.

After completing such courses arrangements for enlistment can be made through the Surgeon-General's Office if the applicant is under draft age, and if of draft age he can be inducted into the service and assigned where his special training will be of value.

This plan has already been tested in two colleges and the success attained has led the Medical Department to apply it to as many colleges as possible. From one such institution every man taking the modified course was admitted directly into the Army and went to one of the training schools, where a portion of them will later qualify for commissions in the Sanitary Corps. Others have qualified for positions at field or mobile laboratory units and as assistants in base and evacuation hospitals.

[1] Publication authorized by the War Department from the office of the Surgeon General.

SCIENTIFIC NOTES AND NEWS

DR. JAMES F. NORRIS, who has been with the Bureau of Mines Experiment Station, has been commissioned a lieutenant-colonel in the Chemical Service Section of the National Army and is to be stationed in London as the

representative of the Army, in chemical warfare, in England. The following men, all in the Chemical Service Section, are to be with him to help in the work: Captain A. B. Ray, Captain G. M. Rollason, Lieutenant H. A. F. Eaton, and First Sergeants E. O. Hobbs, L. C. Benedict, C. E. Wood and J. A. Bowers.

Captain Laurence Martin, of the geological department of the University of Wisconsin, was commissioned as a major on July 23, and has been detailed for duty with the Federal Staff Corps.

Professor V. H. Wells, of the department of mathematics, of the University of Pittsburgh, has been commissioned a lieutenant in the science and research division of the signal corps.

Dr. S. A. Mitchell, director of the Leander McCormick Observatory of the University of Virginia, is at present in Jersey City engaged as instructor in navigation for the U. S. Shipping Board.

Mr. William J. Hammer, consulting physicist and electrical engineer, of New York, has been commissioned a major in the National Army, and is assigned to duty in Washington with the newly organized Inventions Section of the General Staff.

Professor T. D. Beckwith, head bacteriologist of the Oregon Agricultural College, has been commissioned captain in the Sanitary Corps and is ordered to report at the Rockefeller Institute for Medical Research at New York.

Professor F. B. Sanborn, a member of the Tufts College faculty since 1899 and head of the department of civil engineering since 1901, has resigned to enter business in Boston. His firm is now engaged in important manufacturing work for the government.

Mr. Neil M. Judd, assistant curator of anthropology in the National Museum, has recently returned from explorations of the House Rock valley and the Pahreah and Wahalla plateaus, on the north rim of the Grand Canyon in northern Arizona. Several cliff dwellings and ruins were discovered. Since his return to Washington, Mr. Judd has enlisted in the aviation section of the Signal Corps.

Mr. F. T. Sun, director of a fisheries school at Tientsin, China, established and maintained by the Province of Chihli, is in the United States in order to gather information and material for his school, which is devoted principally to the preparation and utilization of fishery products.

Dr. Hans Moore, director, and Albert Scheret, professor, in the agricultural college near Lucerne, Switzerland, are studying methods of agriculture in the United States.

Professor Joseph S. Ames, director of the physical laboratory in the Johns Hopkins University, recently gave the annual address at the University of Virginia before the Phi Beta Kappa Society. The title of the address was "The Value of the Scientific Man in War."

Miss Stephenson has offered £2,500 to endow a studentship in the faculty of arts at Armstrong College, Newcastle, in memory of her father, the late Sir William Haswell Stephenson.

The name of the Memorial Institute for Infectious Diseases, founded in the memory of John Rockefeller McCormick, has been changed to The John McCormick Institute for Infectious Diseases.

Henry Shaler Williams, emeritus professor of geology at Cornell University, died of pleurisy, on July 31, at Havana, aged seventy-one years. He was born in Ithaca in 1847, graduated from Yale in 1868 and held the professorship of natural science in the University of Kentucky from 1871 to 1872. He was professor of geology in the same university from 1880 to 1892 and Silliman professor at Yale University from 1892 to 1904. His research work in Cuba resulted in the development of oil fields in the island.

Dr. John Duer Irving, professor of economic geology at Yale University, known for his work in ore deposits, has died of pneumonia in France, aged forty-four years. Professor Irving was one of the first from the Yale

faculty to volunteer for service at the outbreak of the war, joining the New York Engineer Corps.

Professor A. L. Daniels, Williams professor of mathematics in the University of Vermont, died on July 18, aged sixty-nine years. He was made professor emeritus, on the Carnegie Foundation, in 1914, after a service of twenty-nine years.

Dr. E. W. Sanford, of the Johns Hopkins University faculty, has died in Centerville, Conn., from blood poisoning produced by accidental inoculation while engaged in research work for the government.

Dr. Ludwig Edinger, director of the Neurologic Institute of Frankfort-on-Main, known for his work in the comparative anatomy of the nervous system, has died at the age of sixty-three years.

The death is announced of Dr. Régis, professor of mental diseases at Bordeaux.

Dr. Miguel Sanchez-Toledo, professor of physiology at the University of Havana, died on July 13.

Gifts to the Brooklyn Institute of Arts and Sciences amounting to $70,000 were reported at the June meeting of the board of trustees. Of this amount $60,000 was given by Mr. Samuel P. Avery for the endowment of the Institute's department of education, and $10,000 by two unnamed donors for the endowment of the Brooklyn Botanic Garden, a division of the institute. The terms of the Botanic Garden gift stipulate that it shall be known permanently as the "Benjamin Stuart Gager Fund," in memory of Director Gager's little son who died last spring.

The Bureau of Oil Conservation, Oil Division, U. S. Fuel Administration, is desirous of securing a combustion engineer for each of the following districts, who will act as an inspector visiting all plants within his district using fuel oil and natural gas: Boston, Providence, New York City, Philadelphia, Pittsburgh, Buffalo, Detroit, Chicago, Minneapolis, Tulsa, New Orleans and San Francisco. It is desirable that these men should act as volunteers where possible, but the Administration is prepared to pay a reasonable compensation for men who can not afford to give their services to the government. Only men who have had experience in fuel oil and natural gas combustion would be of value.

An editorial note in *Nature* asks: "Is the Carnegie Trust for the Universities of Scotland doing its duty in strengthening and developing scientific study and research? That is the question suggested by the report of a special committee published in the December number of the Journal of the British Science Guild. The question was first raised in an incisive manner by Professor Soddy in an article communicated to *Science Progress* (January, 1917), and further inquiry seems to show that his contention is well founded. There may be some difference of opinion as to the exact interpretation of Clause A of the Trust Constitution; but there can be no doubt that the main object of the trust is to foster science, pure and applied, in all its branches, and to strengthen that side of university education which is of direct technical or commercial value. In the light of that general principle the following facts are well worthy of careful consideration: (1) Only 14 per cent. of the available funds have been expended on scientific research; (2) by endowment out of Carnegie Funds of certain scientific departments, money formerly spent in their maintenance has been diverted into other channls, so that the university on its scientific side has not really been strengthened; (3) among the twenty-two members of the board of trustees, there have never been more, and have usually been fewer, than four who could be regarded as representing science, the majority being practically ignorant of the methods, and even the meaning, of research."

UNIVERSITY AND EDUCATIONAL NEWS

The University of London has received a bequest of £2,000 for the engineering faculty of King's College under the will of Lieutenant R. C. Hodson, a former student in the enginering department of the college, who was

killed in France last year, and a donation of £51 from Miss Gertrude Jones for the purposes of the Galton Laboratory at University College.

President J. G. Schurman, of Cornell University, has received leave of absence from the university until next October and will devote the summer to patriotic work in France. During his absence, Professor Dexter S. Kimball, acting dean of Sibley College, is, by appointment of the board of trustees, acting president of the university.

At the University of Minnesota Professor H. H. Kildee has resigned as professor and chief of the dairy husbandry division in order to become head of the department of animal industry at the State College of Iowa at Ames; G. E. Weaver and H. R. Searles have resigned as assistant professor and intructor, respectively, of dairy husbandry to enter government service with the marines; Miss Josephine T. Berry has resigned as professor of nutrition and chief of the Division of Home Economics in order to continue her work as assistant director for home economics of the Federal Board for Vocational Education; Miss Mildred Weigley who has been associate professor and acting chief during Miss Berry's leave of absence has been promoted to the position made vacant by Miss Berry's resignation. I. D. Charlton has resigned as professor and chief of the Division of Farm Engineering in order to enter war service; J. S. Montgomery has resigned his position as associate professor of animal husbandry in charge of the section of horse husbandry in order to accept a position with a large stock breeder.

Mr. A. M. Chickering, instructor in biology in Beloit College for several years, has been elected to the professorship of biology in Albion College and will assume his new duties with the opening of college in September.

Miss Alice M. Boring has resigned as associate professor of zoology at the University of Maine and received an appointment in the premedical department of the Peking Union Medical College, China.

Dr. Seth Lake Strong, who was graduated from the Harvard Medical School in the class of 1913, has been appointed lecturer in surgery to the Royal Medical College at Bangkok, Siam, and will also act as surgeon to the Siravaj Hospital there.

Captain M. J. Stewart has been elected professor of pathology and bacteriology in the University of Leeds. He received his commission in 1915 and has served as pathologist to the East Leeds War Hospital, and in a similar capacity in France. A few months ago he was recalled to Leeds and undertook the acting headship of the department of pathology and bacteriology.

The following appointments are announced in the geological sciences in Germany and Austria: Professor W. Branca has retired from his professorship in Berlin, and has been succeeded by Professor J. Pompecki, of Tübingen. Professor E. Kayser has similarly retired in Marburg, and his successor is Professor R. Wedekind. Professor L. Milch, of Greifswald, has followed the late Professor Hintze as professor of mineralogy in Breslau, and Professor E. Hennig, of Berlin, has become professor of geology at Tübingen. Professor O. Abel has been made professor of paleobiology in Vienna.

DISCUSSION AND CORRESPONDENCE

FORMATIVE SETTING OF LACCOLITHIC MOUNTAINS

Although the simple "Blister" hypothesis of laccolithic intrusion, which was for the first time proposed for the Henry Mountains in southern Utah, finds so few supporters, of late little is done towards arriving at a better solution. Perusal of the descriptions of the Henry Mountains soon discloses the fact that not all of their story is yet told. There is nowhere any suggestion of relationships possibly existing between the local tectonics and the intrusive structures. Without these the phenomenon seems, as has been so often urged, a mechanical impossibility. This is the view which most Europeans take. In consequence they frequently confound laccolithic structure with that presented by denuded volcanic necks.

A number of facts militates strongly against the Henry Mountains explanation of laccolithic protuberance. Three basic premises appear wholly untenable. Most vitiating is the seeming incompetency of simple hydrostatic pressure to produce the desired results. Inadequacy of relative lithologic density is now commonly conceded. There also appears to be a radical disparity between the physical conditions accompanying the formation of laccoliths and their once supposed nearest kin the sills.

On the other hand the recent unearthing of the infrabasal make-up of certain laccoliths clearly points to a fundamental dependence of this class of mountains upon prior geologic structure. The shape of laccolithic masses is found to be cuneiform instead of lenticular; and thus at once does away with the blister idea. Quite essential appears to be the presence of crustal lines of weakness. The magmatic swelling or localization of laccoliths is discovered to be a direct function of orographic potentialities.

In seeking an immediate cause for his laccolithic intrusion Professor Gilbert did not lose sight of certain mechanical shortcomings of his explanation. These he sought to overcome by appealing to certain associated factors, which, however, later, Doctor Cross showed to be both unnecessary and not demonstrated as such. Professor J. D. Dana got over the difficulties by brushing aside all considerations except simple hydrostatic pressure and with this feature alone regarded the Gilbertian hypothesis complete. This is doubtless one of the main reasons why from a mechanical angle leading European geologists have so persistently challenged the American view of laccolithic intrusion. At the same time Old World writers on the theme offer no alternative theory to take the place of the one which they seek to discredit. Through the results of close inspection of certain laccoliths of northern New Mexico the chief objections which were raised against the Gilbert view seem to be fully met. Controlling tectonic factors which all describers of laccoliths have missed thus appear to supply the long sought desiderata.

As a primary consideration in order that a laccolith be produced rather than any other form of volcanic manifestation it appears that the intrusive mass shall have a particular tectonic setting. Profound faulting is one of these prime factors. Another is orographic flexing by which the rigidity of certain arching strata largely maintains the load of superincumbent materials. Probably the high viscosity of acidic magmas has an important but as yet uncalculated influence on events. The remarkable infrabasal structure which the New Mexico laccoliths reveal carries the inquiry a step more remote and explains the deep-seated cause of the major faulting, whereby an orographic prism is sustained by a sharp Pre-Cambrian arch, the rigidity of which is not even yet lost although the adjoining blocks on either side are allowed to slide down, as it were, the steep sides of the old flexure.

Now at the southern terminus of the Rocky Mountain Cordillera, in northern New Mexico, there is a succession of open flexures, the amplitude of which grows less as they recede from the main axis. It is where these folds cross great fault lines that laccoliths form. Thus through direct mathematical analysis of the tectonic problems presented and in the satisfaction of the most urgent tectonic demands an adequate *raison d'être* for laccolithic genesis and location seems to be offered.

Charles Keyes

SOIL REACTION AND THE PRESENCE OF AZOTOBACTER

During the summer of 1917 the writer conducted a preliminary survey of local soils to ascertain the relative nitrogen-fixing ability and prevalence of *Azotobacter*. Ninety soils were collected within two miles of the laboratory. The samples were taken from as widely varying soil conditions as could be located including the following: cultivated, permanent alfalfa, bluegrass sod, native pasture, barren hilltops, river bottom, sand bar, roadside and forest.

When cultured in a standard alkaline mannite solution 41 per cent. of the soils failed to show any *Azotobacter* growth. The average nitrogen fixed, per 100 c.c. cultural solution, in such cultures was 7.76 mg. The average nitrogen fixed in cultures showing *Azotobacter* was 16.22 mg. per 100 c.c. cultural solution.

A study of the reaction of these soils gave very interesting results. The hydrogen ion concentration of an aqueous extract of the soils was measured by the colorimetric method outlined by Clark and Lubs.[1]

The range of hydrogen ion concentration in the soil extracts, prepared by shaking one part of soil with one part of water and centrifuging expressed in P_H was from 5.3 to 7.8. All of the extracts from soils which developed *Azotobacter,* with the exception of three, gave a P_H of 6.0 or above. All of those which failed to give *Azotobacter,* with the exception of three, gave a P_H of 5.9 or less. These results would indicate that the absolute reaction is probably the major factor controlling the presence of *Azotobacter* in soils.

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[1] *Journal of Bacteriology,* Vol. 2, Nos. 1, 2 and 3.

DESIGNATION OF SPECIALIZING PHYSICISTS

PHYSICISTS specializing along certain definite lines in such a way or to such a degree that the broad term physicist is not sufficiently descriptive of their professional activities, are frequently at a loss for a suitable designation. For example, a physicist engaged in industrial physics along the lines of electricity may not consider himself an electrical engineer, and still less an "electrician" in the ordinarily accepted use of the term. What shall he call himself? A physicist specializing in mechanics may be neither a mechanical engineer nor a mechanic or mechanician. Similarly one specializing in heat may not be a heating engineer, and one in light may be no optician. The specialist in sound who is now coming into recognition more and more has not even the restricted range of choice given to the others cited.

The answer proposed to the above problem involves a new set of designations of the main subdivisions of the broad science of physics, designations obvious enough in themselves, which commend themselves as logical and acceptable from a terminological standpoint, quite apart from the solution thereby offered of the question raised in the foregoing. It will be noted that the terms being derived from the classic Greek, are international. The following table will make the matter clear.

The Science of	Proposed Designation	Designation of Specialist
Mechanics	Mechanology	Mechanologist
Sound	Phonology	Phonologist
Heat	Thermology	Thermologist
Light	Photology	Photologist
Electricity	Electrology	Electrologist
Magnetics	Magnetology	Magnetologist
Radiation	Radiology	Radiologist

A suggested sample definition is as follows: A mechanologist is a person who is versed in the science of mechanics, or mechanology, and who may, in addition, be skilled in applying the science.

The terms proposed are so obvious that there is no need to make an extended argument in favor of their adoption. The proposals are made with the thought that the need for such terms will become more and more evident through the increased entrance of physics and physicists into industrial and practical work, and it is well that a suitable terminology should be ready at hand for adoption as required.

CLAYTON H. SHARP
ELECTRICAL TESTING LABORATORIES,
NEW YORK CITY,
April 24, 1918

SCIENTIFIC BOOKS

The Science and Practice of Photography. By JOHN R. ROEBUCK. New York, D. Appleton and Company. 1918. Pp. VIII + 298. $2.00.

In this book Dr. Roebuck publishes the course in photography which has been given under his direction at the University of Wisconsin.

In the teaching of photography to students the tendency has been to lay great emphasis on the chemistry of the subject while the physics of photography, which is at least as important as the chemistry, has too often been ignored. Dr. Roebuck has approached the subject from the standpoint of the physicist rather than from that of the chemist, with the result that in this book there is given a clear and valuable exposition of the elementary principles of sensitometry, that is, of the properties of photographic material and its behavior during exposure and development.

The chemistry of the book is distinctly weak, there is practically no discussion of the chemistry of development, and the few equations given for the action of developers are very much open to question. There are also a few obvious errors in chemistry such as the statement that Stas was a German, or that hydrochloric acid can be added to silver nitrate in order to produce an acid emulsion.

In the portion of the book dealing with general theory the author commences with a brief chapter on the historical development of the subject and then deals with the sensitometry of the gelatine dry plate. A short chapter then discusses the subject of color sensitiveness, and another, theories of the latent image. Further chapters deal with negative defects, a very practical chapter indeed, positive processes, lenses, color photography, and the general principles of composition.

The second part of the book consists of a laboratory manual containing a series of experiments to be performed by the student. This will be very valuable to any teacher arranging a course in photography and a student who has worked thoroughly through the course, repeating the more elementary portions several times, will have had a good training in the elements of the subject.

On the whole the book forms a valuable addition to the scanty list of modern works on photography and is to be recommended to all those who are interested in the scientific side of the subject.

C. E. K. MEES

ROCHESTER, N. Y.

THE PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES

THE first number of Volume 4 of the *Proceedings of the National Academy of Sciences* contains the following articles:

The Basal Katabolism of Cattle and Other Species: Henry P. Armsby, J. August Fries and Winfred W. Braman, Institute of Animal Nutrition, the Pennsylvania State College. The results show that the basal katabolism of different species is substantially proportional to their body surface.

The Location of the Sun's Magnetic Axis: F. H. Seares, A. van Maanen and F. Ellerman, Mount Wilson Solar Observatory, Carnegie Institution of Washington. In extension of the work of George E. Hale, a large number of observations were undertaken to determine the position of the sun's magnetic axis, which is found to lie near the axis of rotation at an inclination of about 6°, and to revolve about the axis of rotation in about 32 days.

Resonance and Ionization Potentials for Electrons in Cadmium, Zinc and Potassium Vapors: John T. Tate and Paul D. Foote, University of Minnesota and Bureau of Standards. The results agree within the limits of experimental error with the values as calculated from the quantum relation $h\nu = eV$, where ν is the frequency of the single radiation in the case of resonance potentials or the limiting frequency of the series of radiations in the case of ionization potentials.

The Validity of the Equation $P = dv/dT$ in Thermo-Electricity: Edwin H. Hall, Jefferson Physical Laboratory, Harvard University. The equation is known to be unverified experimentally. The author gives a brief, critical discussion of the validity of some theoretical proofs by which the equation has been deduced.

On the Equations of the Rectangular Interferometer: Carl Barus, Department of Physics, Brown University. A discussion under the under the headings of: Auxiliary Mirror, Rotating Doublet, Ocular Micrometer, Collimator Micrometer.

The Brain Weight in Relation to the Body Length and also the Partition of Non-Protein Nitrogen, in the Brain of the Gray Snapper (Neomœnis Griseus): Shinkishi Hatai, Tortugas Laboratory, Carnegie Institute of Washington and The Wistar Institute of Anatomy and Biology.

The Rotation and Radial Velocity of the Central Part of the Andromeda Nebula: F. G. Pease, Mount Wilson Solar Observatory, Carnegie Institution of Washington. The radical velocity —316 km. is found. The change of rotation velocity with distance from the center seems to be linear.

The second number of Volume 4 contains the following articles:

The Heat Capacity of Electro-Positive Metals and the Thermal Energy of Free Electrons: Gilbert N. Lewis, E. D. Eastman and W. H. Rodebush, Chemical Laboratory, University of California. The experiments go to indicate that in the metals considered the difference between the heat capacity observed and that calculated may be regarded as representing the actual heat capacity of the more loosely bound electrons in these metals.

Thermo-Electric Diagrams on the P-V-Plane: Edwin H. Hall, Jefferson Physical Laboratory, Harvard University. An analysis of the electro-motive force of a thermoelectric circuit on the assumption that the "free" electrons within the metals are the only ones moving progressively in the maintenance of a current, and the only ones taking part in thermo-electric action.

A Determination of the Solar Motion and the Stream Motion Based on Radial Velocities and Absolute Magnitudes: Gustaf Stromberg, Mount Wilson Solar Observatory, Carnegie Institution of Washington. The stream motion is probably a local effect caused by a preferential motion of the stars in both directions around the center of the stellar system. There appears to be a tendency towards smaller values of the declination of the sun's apex for the intrinsically faint stars.

Disease Resistance in Cabbage: L. R. Jones, College of Agriculture, University of Wisconsin. In every case the selected head strains transmitted in considerable degree their resistant qualities, and certain of them did so in high degree. A discussion of the results in their general significance is also given.

Is a Moving Star Retarded by the Reaction of its Own Radiation? Leigh Page, Sloane Physical Laboratory, Yale University. An extended analysis of the forces acting upon the electron leads to the conclusion that the moving electron, and hence any moving matter, suffers no retardation through its motion.

On Electromagnetic Induction and Relative Motion: II. S. J. Barnett, Department of Physics, Ohio State University. The experiments appear to support the hypothesis for the existence of the ether, and to be inconsistent with the principle of relativity.

National Research Council: Report of the Committee on Anthropology.

Notice of Biographical Memoirs: John Shaw Billings; By S. Weir Mitchell and Fielding H. Garrison.

The third number of Volume 4 contains the following articles:

The Effect of Artificial Selection on Bristle Number in Drosophila Ampelophila and its Interpretations: Fernandus Payne, Zoological Laboratory, Indiana University. There are, at least, two factors for extra bristle number, one of them located in the first, and one in the third chromosome.

The Reactions of the Melanophores of Amiurus to Light and to Adrenalin: A. W. L. Bray, Zoological Laboratory, Museum of Comparative Zoology, Harvard College. The melanophores in the skin of the *Amiurus* react to direct stimulation by adrenalin, and are subject to nervous control mediated through the eye.

Further Experiments on the Sex of Parthenogenetic Frogs: Jacques Loeb, Rockefeller Institute for Medical Research. The frogs produced by artificial parthenogenesis can develop into adults of full size and entirely normal character.

The Resolving Powers of X-Ray Spectrometers and the Tungsten X-Ray Spectrum: Elmer Dershem, Department of Physics, University of Illinois. The theory of resolving power is given with the results of experiments on tungsten, in which the endeavor was made to obtain as high a resolving power as possible.

Note on Methods of Observing Potential Differences Induced by the Earth's Magnetic Field in an Insulated Moving Wire: Carl Barus and Maxwell Barus, Department of Physics, Brown University. A simple apparatus is described, and an elementary estimate first given. The apparatus was then modified, producing intensification, and new observations were made.

Dependence of the Spectral Relation of Double Stars upon Distance: C. D. Perrine, Observatorio Nacional Argentino, Cordoba. There is an indication that some external cause is operating in more or less definite regions of our stellar system upon the conditions which produce spectral class.

Hypothesis to Account for the Spectral Conditions of the Stars: C. D. Perrine, Observatorio Nacional Argentino, Cordoba. The spectral condition of a star depends chiefly upon its size and mass and the external conditions of density of cosmical matter and relative velocities of star and matter.

National Research Council: Minutes of the thirty-fourth, thirty-fifth and thirty-sixth meetings of the Committee; war organization of the National Research Council.

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SPECIAL ARTICLES

TERNARY SYSTEMS AND THE BEHAVIOR OF PROTOPLASM

I

IN order to define more accurately the nature of certain changes which are observed in protoplasm (its normal water content, edema, cloudy swelling, fatty degeneration, necrosis) we have been continuing our study of the behavior of various simple colloids so far as their powers of hydration and dehydration are concerned under the influence of changes in their surroundings. Since the chemistry of the proteins is rather complicated, we have turned to a study of the colloid behavior of the chemically simpler soaps, for these show close analogy in their processes of hydration and dehydration to certain proteins. The soaps, however, behave in their turn much like mutually soluble systems of the type phenol-water-salt, and so we have passed from a study of the soaps to a study of these simpler physico-chemical systems. From these we have then built backwards through the soaps to the proteins and from these to the properties of living cells. The study as a whole makes clearer, we think, the nature of various changes which are observed in living matter. Many of the "vital" phenomena of cells may be interpreted in the terms of the behavior of simple hydrophilic colloids. These in turn, may be interpreted as expressions of the changes to be observed in systems of mutually soluble materials (like two liquids and a solid, a liquid and two solids, etc.) more particularly the changes incident to their "separation" in their "critical realms" with the accompanying changes in viscosity, in light transmission, in state of "solvent" or "dissolved" substances, etc.

II

Our studies on soaps not only corroborate the work of various well-known authors (Hofmeister, Lewkowitch, Krafft, Merklen, Goldschmidt, Botazzi, Victorow and Leimdörfer), but amplify their studies in that we worked with pure (salt-free) soaps and with longer series of such while subjecting them to more widely varying external conditions than is the case in most of the investigations thus far reported.

We began with the preparation of equimolar amounts of various salt-free soaps in the presence of a definite volume of water. For this purpose we neutralized (at the temperature of boiling water) the proper fatty acid with an equivalent of the proper alkali in a unit volume of water. When not otherwise speci-

fied, our standard soap mixtures contain the proportions represented by a mol of the fatty acid neutralized by the gram equivalent of the proper metallic hydroxide, oxide or carbonate in the presence of a little water.

As long known from empiric practise, the different soaps bind totally different quantities of water. We first determined the absolute amounts of water that are absorbed by equimolar amounts of different *oleates* when prepared as described above. If that capable of holding most water is named first, the order in which these different soaps absorb water is about as follows; potassium, sodium, ammonium (?), lithium, magnesium, calcium, lead, mercury. Under the conditions of our experiments the first four bind all the water offered them (several hundred per cent.). Magnesium, however, holds but sixty per cent. its weight of water, and calcium oleate but forty. Even lower figures (about 10 per cent.) are obtained for the oleates of mercury and lead.

This general order in which the oleates with different basic radicals hold water is repeated by the *palmitates, margarates* and *stearates.* If the amount of water used in the preparation of the molar equivalents of soap is sufficiently reduced (to one fourth that stated above) then this same order may also be discovered in the case of the *caprylates.* These general findings seem therefore to justify the conclusion that *a first factor in the determination of the amount of water held by any soap resides in the nature of the basic radical combined with the fatty acid.*

We tried next to determine the effect of combining the same basic radical with different fatty acids of the same series. In these experiments we again neutralized one mol of the fatty acid with an equivalent of the necessary base (sodium or potassium hydroxide) in the presence of a constant volume (one liter) of water. The absolute amount of water taken up by a mol of any of these salts, as determined by discovering the maximum amount of water which such will take up at room temperature and yield a stiff jelly, increases progressively with the increase in the molecular weight of the fatty acid used. The absolute amounts of water absorbed vary enormously. From the lower members of the series (from the formates through the caproates) no colloid jellies at all can be obtained. The crossing line is well marked by sodium or potassium caprylate. These soaps form clear (molecular) solutions in twice their weight of water but they form jellies with once their weight of water. The amount of water that will be thus taken up and yield a jelly increases progressively as acids above caprylic are used so that by the time stearic acid is reached, one part of soap will easily take up a hundred or even two hundred times its weight of water and form a solid mass. Experiments with fatty acids beyond stearic are not yet completed. Obviously then, with a given base, *a second element in the amount of water held by a soap depends upon the nature of the fatty acid contained in the soap and its height in the series.*

We tried next the effects of different alkalies, of different neutral salts and of different non-electrolytes upon the hydration capacity of different soaps (caprylates, laurates, oleates, palmitates, margarates and stearates of sodium and potassium). Our conclusions under this head may be summed up as follows:

1. The addition of any *alkali* to a "solution" of any of these soaps at first increases its viscosity or (in a limited volume of water) leads to its gelation; with higher concentration of the added alkali, there follows a decrease in viscosity ("liquefaction") which change is succeeded, at sufficiently high concentration of the alkali by complete separation of the soap from the dispersion medium as a dry mass floating upon the "solvent." When equimolar solutions of the different soaps are compared it is found that the effects of an added alkali vary with (*a*) the fatty acid in the soap, (*b*) the base combined with the soap and (*c*) the basic radical of the added alkali. The lowermost members of the fatty acid series neither gel nor come out of "solution" upon addition of an alkali. The caprylates gel and come out easily while the higher soaps show these changes in increasingly marked

degree. When potassium and sodium soaps are compared, it is found that an added alkali will produce the series of changes earlier in a sodium soap than in a potassium soap. Similarly, if the effects are compared of adding equinormal solutions of potassium or sodium hydroxide to a given soap the former is found not so effective (in other words, a higher concentration is demanded to produce the series of changes noted above) as the latter. When solutions of the hydroxides of the bivalent or trivalent metals are used, the effects of the metallic radicals and the formation of metallic soaps with their low hydration capacity dominate the picture. Such hydroxides, therefore, lead uniformly only to decrease in viscosity and separation of the slightly hydrated soap from the dispersion mediums.

2. The addition of *salts* of the bivalent and trivalent metals to potassium, sodium, ammonium and lithium soaps leads to a clouding of the mixtures, a decrease in viscosity and a decrease in power to gel. The picture is again dominated, in other words, by the production of the metallic soaps with their low hydration capacities. A more careful study of the hydration and dehydration of the soaps of the alkali metals under the influence of various salts is therefore, limited to the salts of the alkali metals. As generally known in technological practise, these salts lead to a "salting out" of the soap, or, when used in smaller amounts, to a "gumming" or "stringing" of the soap. We were able to confirm and amplify here the investigations of other workers in this field which have shown that such gumming and ultimate salting out are dependent upon the concentration and the chemical nature of the salt used. With rare exceptions (more particularly those salts which in aqueous solutions are not "neutral") all the ordinary salts of potassium, sodium, lithium, etc., at first increase the viscosity of a potassium or sodium soap to a point where at proper concentration a soap jelly results, beyond which further increase leads to a fall in viscosity (liquefaction) until, in still higher concentrations of the salt, the soap begins to separate from its clear dispersion medium, at first as a cloudy jelly and then as a (practically dry) dehydrated soap mass swimming upon the clear "solvent."

The intensity with which these successive changes are brought about again varies, at the same concentration of salt, with the fatty acid in the soap, the nature of the basic radical in the soap and the basic radical of the salt used. Potassium salts, for example, are less effective in bringing about the series of changes than the corresponding sodium or lithium salts.

The acid radical (fluoride, chloride, bromide, iodide, nitrate, sulphocyanate, sulphate, acetate, tartrate, citrate) in the series employed by us seems to influence the end results so little as to come within the limits of experimental error. In other words, with salts of a given base the acid radical is practically of immaterial importance.

When *an alkali and a salt are together added* to a soap, the action of the two is found to be algebraically additive. An alkalinized soap may be salted out by adding a neutral salt and at a concentration of the latter which would not by itself have proved effective. Vice versa, a partially salted soap may be completely dehydrated by adding an alkali to a concentration at which the alkali alone would have produced no such effect.

It is also of interest that all these effects of alkali, of salts, etc., are largely reversible. A soap dehydrated by an alkali or a salt can be rehydrated by merely adding water; a soap partially dehydrated by a sodium salt can be rehydrated by substituting a potassium salt, etc. Most interesting, however (and physiologically important), is the fact that magnesium, calcium and even iron and copper soaps can, through the addition of the proper salts or hydroxides of the alkali metals, be slowly brought back into the more highly hydrated soaps of these alkali metals.

3. The *non-electrolytes* (alcohol, glycerin, dextrose, saccharose, lactose, urea) as compared with the electrolytes have at the same concentration relatively little effect upon the hydration and dehydration of soaps. They

tend in general to inhibit that series of changes which may be brought about in soaps through a lowering of temperature, the addition of alkali, the addition of salt, etc.

These findings indicate, therefore, that *a third element in the hydration and dehydration of soaps is resident in the kind and concentration of various alkalies, salts or non-electrolytes which may be present in the system.*

Great care is necessary before it is assumed that in order to understand the behavior of any *mixture of soaps* it is only necessary to compound the behavior of the individual pure soaps. The higher fatty acids uniformly yield soaps of the highest absolute hydration capacity, and yet if mixtures of a higher fatty acid soap and one lower in the series are prepared at the temperature of boiling water, the physical properties of the system on cooling are dominated by those characteristic of the *lower* fatty acid soaps. A hydrated sodium or potassium stearate, margarate or palmitate which at room temperature is absolutely solid becomes only viscid or remains distinctly liquid when small amounts of the caprylates, laurates or oleates are mixed with the stearate.

III

It must first be pointed out that *all the laws here emphasized as governing the hydration and dehydration of soaps are identical with those which govern the hydration and dehydration of certain proteins (like the globulins).* Whatever is the ultimately accepted theory of the nature of the action of the elements enumerated above in producing hydration and dehydration ("precipitation") in soaps, this will also prove to be the accepted one for this class of proteins. As the soaps (but not the fatty acids) are "soluble" in water so also are the alkalinized globulins (but not neutral globulin). As low concentrations of the alkali metals favor the hydration of soaps, thus also do they favor the hydration of globulin; on the other hand, as these same salts in higher concentrations "salt out" the former, so also do they salt out the latter. As the heavy metals, whether added as hydroxide or as salt, yield sparsely hydrated metallic soaps, so also do they yield sparsely hydrated globulins. As reversion of hydration or dehydration in soaps is easy when the salts of the alkali metals are involved, becomes increasingly difficult with magnesium and calcium compounds and proves only partially successful and then only after a long time when salts of the heavy metals are used, so also are the analogous reversions easy or difficult in the case of the globulins.

IV

To explain these changes in soaps, in various proteins and in living cells which have been subjected to similar changes in their surroundings we turn to the changes which may be seen in mutually soluble systems of the type phenol-water-salt as studied by Friedländer and his followers and as variously considered as of importance for an understanding of the changes in colloids[1] by Hardy, Höber, Wolfgang Ostwald and Hatschek.

Thus, water is soluble in phenol and phenol in water; similarly, water is soluble in soap and soap in water. The maximum viscosity of a phenol-water mixture appears in the critical realm when, under changes in surroundings or composition, phenolated water "separates out" in hydrated phenol or hydrated phenol appears in phenolated water. Soaps, similarly, show a maximum viscosity when a proper hydrated soap is produced in soap water or soap water separates out in hydrated

[1] We accept as the correct definition of "colloid," the dispersion of one material in a second, the degree of dispersion being less than that represented by the molecular degree of subdivision characteristic of "true" solutions. Limiting ourselves to the groups of dispersoids represented by solid-liquid and liquid-liquid mixtures (those of chief interest, biologically) we do not think that the former yield always suspensoids and the latter emulsoids, but that *either* type may result. (Liquid) mercury in water or (liquid) oil in water yield suspensoids while (solid) ferric hydroxide or crystallized albumin in water yield emulsoids. *The emulsoids result when each of the phases is soluble in the other;* the suspensoids when not more than one of the phases is soluble in the other.

soap. When an alkali or a salt is added to a phenol-water or to a soap-water system the "solubility" of each of the three phases in the remaining two changes. A clear "solution" of phenol, water and salt (at definite temperature) can be obtained only at proper concentrations of these three materials. Changes in any of them lead to changes in viscosity, changes in optical properties, changes in the distribution of one or more of the "dissolved" substances in the other phases, etc. This is also true of soap and individual proteins as discussed above and of protoplasm under physiological and pathological circumstances as noted in our earlier papers. What happens depends upon the chemical nature of the original substances entering into the mutually soluble system, their concentration and the temperature.

Applied to protoplasm we incline to the view that this consists of a series of hydrophilic (protein) colloids which have sucked up ("dissolved") a certain amount of water and a certain amount of various salts. The system is not unlike phenol saturated with water and containing "dissolved" in it various electrolytes and non-electrolytes. We hope to discuss in detail later, older experiments and our own which show how, at constant temperature, physical and chemical variation in any one of the substances in such simple systems is followed by change in the remaining ones and this in a fashion identical with certain changes observed in protoplasm. These mutually soluble physico-chemical systems show a normal water content (normal turgor) which may be decreased (cell shrinkage, plasmoptysis) or increased (plasmolysis, edema); accompanying such there are changes in viscosity (drying or swelling of tissues), changes in optical properties ("cloudy" swelling) and changes in distribution of dissolved substances ("vital" absorption or secretion). These changes in physico-chemical systems or in protoplasm may be brought about by changing (1) the fundamental type of the substrate itself (as when calcium or magnesium proteinate is substituted for potassium or sodium proteinate), by changing (2) the concentration of the electrolytes or non-electrolytes acting upon the substrate (either by increasing the amount of an alkaline metal in a cell, or by adding so much that it combines with the water of the cell and leads to protoplasmic dehydration through deprivation of "solvent" as first brought out by Hofmeister), or by changing (3) the chemical character of the salt acting upon the substrate (as when magnesium or iron salts are used instead of salts of the alkali metals). Some of these changes are reversible (like those produced by alkalies or alkali metals, in which case the corresponding tissue changes, as "edema" or "cloudy swelling," are also reversible), while others are not (in which case the changes in protoplasm, like the effects of a heavy metal, are also irreversible or incurable, and the involved tissues are said to suffer "death" or "necrosis").

The effect of changes in temperature upon these ternary (or more complicated) physico-chemical systems is also analogous to the effect of temperature upon protoplasm. As mutual "solubility" may increase or decrease with increase in temperature, a change in the system may occur in one or the other direction. The clearing of a turbid soap-water-salt or a globulin-water-salt system when the temperature is raised illustrates the one type of reaction, the "coagulation" of an albumin the other.

V

This more detailed study on soaps has enabled us also to study further and to *verify our earlier contentions regarding the conditions which make for the maintenance and the breaking of emulsions.* We have previously emphasized that oil can not be emulsified in water to yield an oil-in-water type of emulsion containing more than a fraction of one per cent. of fat, except as a colloid substance is present which unites with the water and forms a colloid hydrate. The truth of this general statement is verified by using as emulsifying agents the soaps described above. The lowermost members of the fatty acid series (which in water form only molecular solutions) do not make emulsification at all pos-

sible. The caprylates, which are the first in the series to show distinct hydrophilic properties, are good emulsifying agents, and, generally speaking, the value of these emulsifying agents increases steadily as we mount in the fatty acid series. An upper optimum is shown by those soaps which (like sodium stearate) are brittle and "dry" at ordinary temperatures. But the potassium soaps of these higher fatty acids are all good emulsifiers as are even the sodium soaps if the temperature is increased whereby the brittle, crystalline, colloid hydrates formed at lower temperatures are converted into more tenacious colloids which bear stretching into thin layers without rupture.

How important is the degree of hydration of the soap for thus stabilizing the emulsions is also well shown when the effects are studied of adding an alkaline salt in progressively higher concentrations to one of the more liquid soaps (like sodium oleate, sodium caprylate, sodium laurate or potassium palmitate, margarate, or stearate). As previously noted, the hydration capacity of the soaps is increased at first, decreased later and finally reduced to zero. Similarly the emulsifying power of the soap at first increases then decreases and finally becomes zero.

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June 15, 1918

FIELD CONFERENCE OF CEREAL PATHOLOGISTS

THE fourth Annual Conference of Cereal Pathologists was held at Purdue University, Lafayette, Ind., beginning June 19 and ending Friday afternoon, June 21. Forty names were signed to the register. A tentative program was presented as a guide for discussion, although no formal program had been prepared in advance. This fact helped to make the meetings more informal and all discussions were in the nature of round-table talks. Certain members were asked to lead in the discussion upon topics in which they were especially interested.

8:30 A.M., June 19—24 Present.

Professor H. P. Barss called the conference to order and after a few introductory remarks the program was taken up.

Barberry Eradication.—Dr. Stakman reported upon progress of the work of barberry eradication. Among other things he brought out the fact that barberries were much more numerous and more widely distributed than had been supposed, that they were quite universally rusted even on well-kept lawns, that in the northern United States, all cases of early infection of stem rust upon grains and grasses had been directly traceable to barberries and that the barberry campaign was succeeding in rapidly clearing the states from Ohio to Montana and from Missouri to Canada of this worthless shrub. He said that reports had come in indicating that 70 to 90 per cent. of the bushes were already out in North Dakota, South Dakota, Minnesota, Wisconsin, Iowa, Michigan, Nebraska and northern Illinois. The fact was also brought out that the common barberry has escaped from cultivation in some few places.

Dr. A. G. Johnson reported finding a hybrid of the common barberry which was infected. He emphasized three points: (1) Barberries spring up from the roots when dug up, if the work is not thoroughly done; (2) seedlings of barberries had been found badly infected; (3) barberries had been located in many obscure places. Mr. Dixon, of Wisconsin, reported on some work upon overwintering of uredinia. He found no overwintering of uredinia in 125 stations visited every two weeks during winter and spring. Dr. Stakman stated that this had also been the experience of various other field scouts both this year and last.

Dr. Coons reported good progress in Michigan and stated that the strong arm of the law was needed to complete the work. All barberries had been removed which could be removed by publicity work. He also stated that no stem rust had been observed until after infection had become common upon barberries.

Professor Selby reported good progress from Ohio. He stated that the attitude of the people in general was to wait for infection.

Professor Jackson stated that the scouting work in Indiana had been confined to the northern part of the state.

Dr. Stevens and Dr. Anderson were both present from Illinois. They stated that infection was abundant in Illinois in the northern part, and down the Mississippi River as far as Rock Island.

Stem Rust Studies.—Dr. Stakman reported very

briefly upon some recent work upon biologic forms of stem rust. He stated that a new strain of *Puccinia graminis* had been sent in from Oregon which had proven to be different than any previously described.

A general discussion followed concerning the general scope of the barberry campaign—the advisability of extending it into other states, etc.

7:45 P.M., June 19—28 Present.

Other Diseases of Wheat, Barley, Rye and Oats.—Dr. Johnson reported upon two distinct bacterial diseases of oats—one "halo blight" and the other striped bacterial disease.

Black chaff bacterial disease of wheat was reported as occurring this year in various states and causing some damage. Bacterial diseases of barley and rye, *Septoria* disease of wheat, *Rhynchosporium* disease of barley, anthracnose and *Helminthosporium* diseases were briefly discussed as to their distribution. This is not included here as such data are given by the Plant Disease Survey Reports.

Dr. A. G. Johnson reported upon some dry heat experiments which seemed to promise to control certain of these seed form diseases which are resistant to common methods of seed treatment.

9:30 A.M., June 20—32 Present.

Leaf Rusts of Cereals.—Leaf rust of wheat and rye was reported as being extremely heavy and extremely abundant in the south and as common in various sections.

Dr. Melhus from Iowa reported *Rhamnus lanceolata*, a native buckthorn, heavily infected in Iowa, and stated that the crown rust of oats goes to this species of *Rhamnus* according to greenhouse tests.

Some discussion followed regarding a method of determining losses by leaf rust.

A short report of recent researches upon stripe rust was given by Mr. Hungerford.

Species of Bunt and their Distribution.—After some general discussion, an effort was made to learn by reports from those present, something regarding the distribution of the two species of bunt. This did not result in any very satisfactory reports and Mr. Potter was finally appointed to look up the distribution of the two forms in various herbaria.

Loose Smut of Wheat.—This discussion brought out nothing which can not be learned from the Plant Disease Survey Reports.

2 P.M., June 20.

Field excursion to Wilson Farm (Experiment Station) in charge of Professors Jackson and Hoffer.

7 P.M. Dinner followed by round-table discussion—40 Present.

After the dinner, a rising vote of thanks was given to Dr. H. S. Jackson and Professor G. M. Hoffer for their hospitality and kindness in arranging for the cereal disease meeting.

At the business session Dr. G. H. Coons was chosen chairman and Dr. Robert Rands, secretary for the coming year.

A committee consisting of Dr. Stakman, Dr. Johnson, Dr. Melhus and Professor Barss was appointed to arrange for the time and place for the next meeting.

Dr. Selby invited the conference to meet in Ohio and Dr. Anderson extended such an invitation from Illinois.

Moved and carried that a committee upon resolutions be appointed—Anderson, Johnson, Stakman and Whetzel appointed.

Bacterial Diseases.—Bacterial diseases and corn rust were very briefly discussed. Professor Barre reported that *Physoderma* disease was one of the most troublesome and serious of all corn diseases. Distribution reported as practically over corn belt, although serious only farther south. A general discussion of corn smut followed.

9 A.M., June 21—36 Present.

Dr. Haskell submitted for criticism and suggestions, blanks prepared by Dr. Lutman for use in cereal disease estimates in Vermont and adopted by the Plant Disease Survey for general use. Several minor suggestions were made.

Smuts of Oats.—A general round-table discussion followed as to the distribution of loose and covered smuts of oats. Mr. Potter was instructed to include oat smuts in the survey work of herbaria in regard to species of bunt.

In the discussion which followed regarding barley smuts and stalk smut of rye, Dr. Coons urged that the treatment for rye smut be pushed so as to prevent its spread. Dr. Johnson raised the question regarding possible introduction of flag smut of wheat on wheat from Australia. It was moved and carried that the committee upon resolutions prepare resolutions to the Federal Horticultural Board in regard to use of wheat from Australia for seed purposes.

Smut Eradication Campaign.—Report by Mr. Reddy of work in North and South Dakota indicated that the main value of work there was in securing treatment of barley and oats.

Professor Barss reported that a standard label for use of druggists in Oregon had been prepared and distributed and that the campaign in Oregon

had resulted in uniformity of methods of treatment.

Mr. Morgan stated that bluestone was commonly used in Alabama and Mississippi and farmers treat every other year. Results of treatment in South Carolina showed control of oat smuts.

Dr. Johnson stated that the campaign had resulted in general stimulation of seed treatment in Wisconsin.

Dr. Reed reported that there was practically no control practised in Louisiana, Arkansas and Missouri. The campaign this year is convincing the people that they have smut and a campaign for eradication can be pushed next year.

Seed Treatment Methods.—General discussion of seed treatment methods and cooperation experiments followed. At Dr. Stakman's suggestion, it was moved and carried that the conference go on record approving the cooperative plan of seed treatment experiments.

Haskell and Iowa Treatments.—Iowa method as described by Dr. Melhus: One pint formaldehyde to ten gallons of water on forty bushels of grain. Grain to be sacked at once.

Dr. Whetzel reported that a certain elevator company near Ithaca, N. Y., was using the concentrated formaldehyde method on a large scale.

It was suggested that the treatment described by Dr. Haskell be known as the concentrated formaldehyde treatment.

Report of Committee upon Resolutions.—The following resolutions were presented by the committee upon resolutions and voted upon in turn, each one passing by unanimous vote:

1. We, the Cereal Pathologists in conference assembled at Lafayette, Indiana, after summarizing the evidence accumulated against the barberry as a spreader of black stem rust,

Do heartily endorse the efforts now being made under the leadership of the Department of Agriculture for the eradication of the forms of barberry and Mahonia, susceptible to black stem rust as a war measure of special importance in the conservation of our cereal food supply.

And be it resolved that we urge upon the Department of Agriculture and the agricultural agencies of the various states that the work be extended as speedily and pushed as vigorously as possible in order to give maximum production.

2. WHEREAS, the control of cereal smuts is of paramount importance and whereas, it is essential to learn the effect of different treatments on seed germination and yield, as used upon various cereals in various regions, under different conditions and on various varieties and seed lots with a view to standardizing treatments insofar as possible. Be it therefore resolved, that we, Cereal Pathologists urge (1) The continuation of the present smut eradication campaign U. S. Department. (2) Endorse and support the efforts now being made under the auspices of the War Emergency Board to solve the problems in connection with cereal seed treatment.

3. WHEREAS, Dr. J. C. Arthur, with rare devotion to science and foresight into the problems of the future, has done a tremendous amount of work fundamental to the development of cereal pathology,

AND WHEREAS, recognizing the fine service he had rendered we wish to express our appreciation of and admiration for this self-sacrificing work.

Be it, therefore resolved that we, the Cereal Pathologists assembled at Lafayette, Ind., June 19–21, do hereby express a sincere vote of thanks to Dr. Arthur for the concrete results he has obtained and the inspiration he has furnished, and be it further resolved, that a copy of this resolution, be sent to Dr. Arthur and also be published in *Phytopathology*.

4. WHEREAS, a large quantity of wheat is being imported into the United States from Australia for food purposes, and

WHEREAS, some of the wheat so imported may be used for seed purposes, and

WHEREAS, certain wheat diseases prevalent in Australia and not now in this country, may thereby be introduced into your country,

Be it resolved, by the cereal pathologists in meeting assembled at Lafayette, Ind., June 19–21, that the Horticultural Board be requested to take immediate steps looking toward the prevention of the introduction of such diseases.

CHAS. W. HUNGERFORD,
Secretary

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